# THE RÖNTGEN METHOD IN LITHIASIS OF THE URINARY TRACT.

BY CARL BECK, M.D.,

OF NEW YORK,

Professor of Surgery in the New York Postgraduate Medical School and Hospital; Visiting Surgeon to the St. Mark's Hospital and the German Poliklinik.

It is one of the strange phenomena in medicine that, in the face of the most abundant proofs of the reliability of renal skiagraphy, some of the best text-books still hesitate to recommend the method, some others even openly warn the practitioner against it. This they do because they have observed or heard of grave errors committed in its employment. Thus it is said, for instance, that skiagraphs taken by the "best experts" have shown renal calculi, while nephrotomy disclosed the absence of any concretion; and on the other hand that cases were reported in which calculi were found at the operation after skiagraphy had failed to show their presence. None of these reports are well founded.

Whatever errors have been committed were of the individual, not of the method; and this should not be held responsible. I have often had to admire the power of imagination of some novices in skiagraphic work, who demonstrated the outlines of calculi as well as of some abdominal organs to me, when I could only find the indications of a dense band of tissue, or a spot in the plate, or a button of the underclothing of a too modest patient. Such visionary powers, while immensely useful in the art of Shakespeare or Goethe, cannot be too strongly reprehended in the domain of science and in the field of the Röntgen rays.

But now, fortunately, skiagraphic technique is so much advanced that it stands in no need of the imagination. A definite diagnosis in suspected lithiasis can be made in each and every instance; in other words, a renal calculus must invariably show, provided a calculus is there.

Lumbar exploration and similar procedures for suspected nephrolithiasis, advised in all text-books, are therefore no longer in order. The Röntgen method not only answers the question, Are calculi present? but gives precise information as to their size, shape, and number. It will also show whether there are any calculi in the ureter or the bladder.

The revolution which the Röntgen method has wrought in this special field is indeed as great as in that of the injuries and diseases of the bones, which after years of struggling, thanks to the untiring efforts of a few imperturbable physicians, is gradually beginning to be appreciated by the profession at large.

The chemical composition of the calculi of the urinary tract determines the greater or lesser depth of their shadows. The greater their atomic weight, the greater their density, and consequently the more distinct the shadow. Thus, calculi composed of oxalate of lime show the most distinct shadows. (See illustrations.) Their shadows are even deeper than those of bone-tissue. Next to them we find those consisting of phosphate of lime, while the uric acid calculi give the faintest shadows.

In practice, however, we often find that calculi are not of one distinct type, and if they are, layers of various degrees of density are observed. Two strata are generally present, then one or the other character predominating. So it will frequently happen that there is a nucleus of uric acid surrounded by alternate layers of the other elements.

This explains why at least some dense areas are struck in all cases of renal calculus. The same is true when the calculi are of small size, like the one, for instance, illustrated in Fig. 1, *C*. But the question of composition is of less importance than that of bringing the calculous area as near to the photographic plate as possible, and keeping the field absolutely quiet.

These two requirements are attained by the use of a tubular diaphragm, which offers another great advantage, that of permitting the passage of the focal rays alone, thus exclud-

ing the vagabonding rays,—viz., those emanating from the tubal wall. (See illustration in "Recent Advances in Röntgen-Ray Diagnosis," *Archives of the Röntgen Ray, etc.*, London, February, 1905.) The disadvantage of the tubular diaphragms is that only small areas can be shown at a time. This disadvantage is little felt in the representation of joints, etc., but in renal or biliary skiagraphy it may be responsible for missing the seat of the calculi.

It is evident, therefore, that in skiagraphy of the urinary tract a general exposure must precede that of a limited area, since it cannot be known beforehand whether the suspected calculi are situated in the ureters or in one or both of the kidneys. In other words, the Röntgen plate must *a priori* include an area bounded by the eleventh rib and the crest of the ilium on one side and by the vertebræ and the anterior axillary line on the other. For this purpose, plates of the size 10-12 or even 11-14 inches are required. Corresponding with each side of the body wire letters are placed. These serve as landmarks for comparison, and at the same time indicate the sides of the body. (Letters R and L.) This is emphasized for the reason that cases are reported in which it has happened that on account of the inverted relations of the negative the wrong side has been incised. In Fig. 1, for instance, which was taken in the abdominal position, the bones are so distinct that an inexperienced eye might take it for a dorsal view, which, of course, would transpose the sides from right to left.

A few more wire letters may be placed in the renal region, to serve as landmarks for the special exposure also. It is useful sometimes to attach the same wire letters to the body by means of adhesive plaster strips, and to skiagraph them together with the wire letters on the plate. We are thus able to compare the relations of the landmarks of body and plate for better localization.

Now, while with the general tentative exposure only faint outlines of the calculi are obtained, as a rule, they may be distinct enough to show at what area the diaphragm should be adjusted to attain the most distinct outlines.

If the large plate proves to be negative, although other means of examination point to the presence of nephrolithiasis (hæmaturia for instance), both renal regions must be separately examined with the aid of the diaphragm, several exposures sometimes being required. This is, of course, troublesome, but, in view of the great importance of a correct diagnosis, it cannot be omitted. Rarely, however, does it happen that many exposures are needed. Two, as a rule, suffice for our information. In this manner I have also been able to show the indications of calcareous deposits produced by renal tuberculosis.

So the *modus operandi* in renal skiagraphy is the following:

The general exposure is preceded by a thorough evacuation of the bowels, followed by the administration of a moderate dose of opium. The patient is in the dorsal position on a large plate covering both lumbar regions. For localization, a few wire letters are distributed over the plate, the R (right side) and L (left side) being placed directly underneath the outer surfaces of the lumbar regions, so that they appear on the integumental margins of the skiagraph. With a pair of calipers their distances from the spinal column and the ribs are ascertained and transferred upon the abdominal surface to be marked there for the proper adjustment of the diaphragm. Head and shoulder are elevated by a few pillows, while the chin touches the sternum. The knees after being flexed are well immobilized by sand-bags. The exposure should last from three to five minutes, according to the thickness of the abdominal tissues to be penetrated. The vacuum of the tube should be soft. I prefer the self-regulating tube of Müller for renal skiagraphy.

The criterion of a good plate is, that the vertebræ, the eleventh and twelfth ribs, and the outlines of the ileopsoas muscle shall be clearly defined. On the other hand, a plate which shows a number of calculus-like shadows, but fails to represent these points, must be regarded as misleading, and should never be used as a guide for operation. The only thing

to do is to try a second and, if necessary, a third or fourth time; the latter, however, seldom being necessary in the hands of a man of some experience.

If the plate is good, and shows the indications of calculi, the tubular diaphragm is now to be applied in the same position as advised for the general exposure, with the difference that the shoulder of the exposed side is elevated somewhat more. It is best pushed below the rib arch in an oblique direction in such a manner that its centre corresponds with the landmarks indicated on the large plate. The oblique direction permits the diaphragm to be pressed deeply into the abdomen, thus reducing the distance between it and the plate to a considerable extent.

The time of diaphragmatic exposure should be two minutes in thin and from four to five in stout individuals.

If the large plate be negative, I resort to a diaphragmatic exposure, nevertheless; and if this shows distinctly the criteria mentioned above, I can positively assure my patient that he does not suffer from nephrolithiasis. (See Fig. 2, left side.)

It is not desirable, however, that the bones mentioned should show textural details. As a rule, the longer the exposure lasts, the clearer the bones show, and the less marked will the calculi appear. Fig. 4, *a*, for instance, represents the result as it should be, while Fig. 2 is over-exposed. Of course, the calculi still show sufficiently clear, but it is characteristic enough that Fig. 1, which is taken without the diaphragm and in the less favorable abdominal position, shows the renal calculi even more distinctly than the diaphragmatic exposure.

From this we also learn that general rules only for the time of exposure can be laid down, the instinct of the more or less experienced operator being an important factor in determining details.

These views apply even more closely to the technique of biliary skiagraphy. As I have often insisted, the reason why so many surgeons have tried in vain to represent biliary calculi is due to the simple fact that they use hard tubes, which penetrate the calculi, so that they, on account of their general

degree of density, are irradiated away, so to speak. In all my successful exposures for biliary calculi the bones appear dark and especially show no textural details.

The principles of renal skiagraphy also apply to that of the urinary bladder. Vesical calculi can, however, be well shown without the aid of the diaphragm (Fig. 1). In stout individuals the diaphragm may sometimes be useful.

The patient is skiagraphed in the recumbent position, the centre of the tube to be directed to the upper margin of the symphysis. The criterion of a good vesical skiagraph is that it well shows the structures of the coccyx. The sacrum should not show any details. By oblique irradiation the shadows of vesical calculi are generally found just below those of the coccyx. An oblique exposure should also be made, because it may show whether the stone is free or encysted. If the patient bend slightly forward in the lateral position, the calculus, if free, sinks towards the anterior vesical wall and becomes conspicuous directly behind the anterior or abdominal wall. If it is not free, it usually shows far back towards the sacrum, since encysted calculi are nearly always attached to the posterior vesical wall. If the stone be of very large size, or if a great number of stones be present, the whole vesical space is filled up, and displacement is not apt to occur.

As far as the diagnosis of the number, shape, and position of the calculi is concerned, the Röntgen method affords more valuable aid than the cystoscope, aside from the fact that a calculus embedded in a diverticulum will escape the cystoscope, while the rays will always detect it. At the same time it should be realized that skiagraphy is a far more comfortable procedure than cystoscopy. The time of exposure is two minutes in children and three to four in adults. A soft vacuum is just as desirable as in renal skiagraphy.

My experience with the Röntgen method has suggested that it is necessary always to skiagraph the renal regions at the same time whenever vesical calculus is suspected. Since I have made this a principle, I have found renal calculus whenever there was a concretion in the bladder. This is not

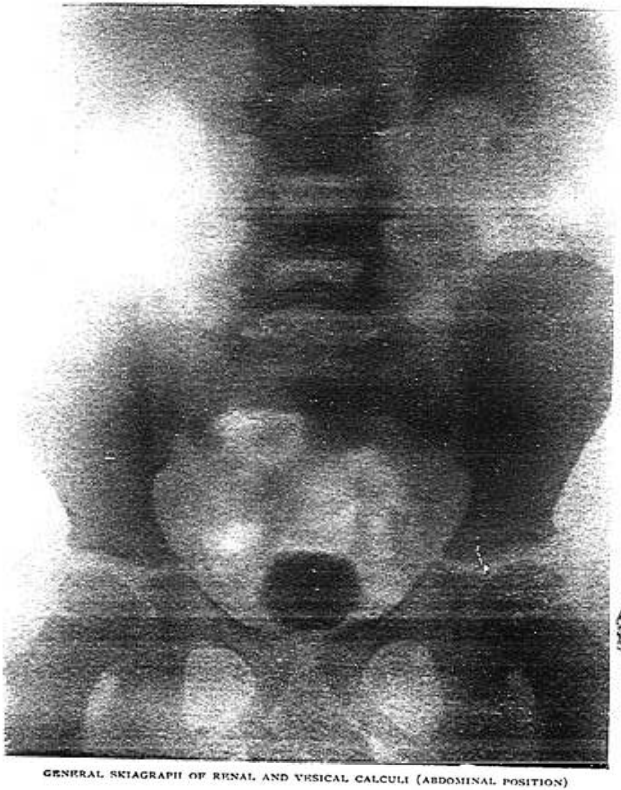
strange, if we realize that most vesical calculi were originally formed in the kidneys. It also explains the frequent recurrence of vesical calculus after operation. Within the last year I have studied three cases in which I operated for recurrent vesical calculus. In all of them skiagraphy revealed the presence of nephrolithiasis.

The first case was that of a woman of thirty-two years, who submitted to lithotripsy a year before I saw her. She was greatly relieved at first, but nine months afterwards she began to suffer from frequent micturition and pain in the vesical region. Skiagraphy demonstrated the presence of a small calculus in the bladder and a larger one in the renal region. I removed the vesical calculus (St. Mark's Hospital), but the patient has since felt so well that she has not concluded to be operated upon for the nephrolithiasis. If the size of the renal calculi is such that they pass the water I do not regard the removal of the renal calculus as an imperative necessity, but advise antilithiatic medical treatment first, the effect of which is studied by the Röntgen method.

Another case, a man of twenty-four years, showed the same history. Suprapubic lithotomy two years before I saw the patient had brought complete relief, the symptoms of recurrence appearing a year afterwards. Skiagraphy revealed a vesical calculus of moderate size and a triangular calculus of large size in the left kidney. The patient submitted to suprapubic lithotomy (St. Mark's Hospital), and so far has not returned to me for interference in the renal region.

The third case is that of a boy of seven years, from whom a large vesical calculus was removed by suprapubic cystotomy three years ago. The relief was complete for about a year when patient again began to suffer from the symptoms of vesical calculus. The parents were at first unwilling to permit of repeated surgical interference, and while hesitating, the patient became thoroughly emaciated. Symptoms of light urosepsis finally constrained the parents to give up their resistance. The general skiagraph (Fig. 1, *a*,) revealed the presence of vesical as well as of renal calculus on the left side. Suprapubic cystotomy was performed at the Post-graduate Hospital, which brought immediate relief from pain and micturition, but had little effect on the

FIG. 1.



GENERAL SKIAGRAPH OF RENAL AND VESICAL CALCULI (ABDOMINAL POSITION)

PHOTOGRAPH SKIAGRAPH
OF
RENAL CALCULI

PHOTOGRAPH SKIAGRAPH
OF
VESICAL CALCULUS

LEFT. FIG. 2. RIGHT.

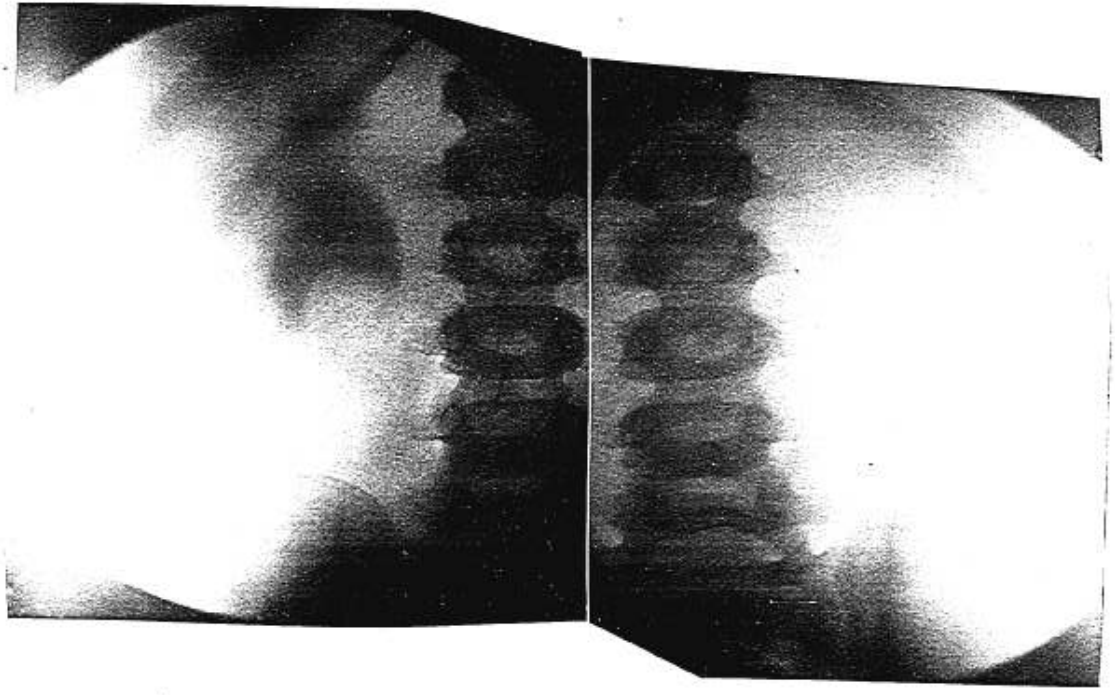


FIG. 2. POSTERIOR DIAPHRAGMATIC EXPOSURE, SHOWING CALCULI ON THE RIGHT AND NORMAL CONDITIONS ON THE LEFT

pyelitic symptoms. The extreme exhaustion of the patient seemed to me a contraindication to immediate nephrotomy, and I tried to keep the patient up by stimulation, at the same time giving urotropin internally. Three weeks afterwards, when the vesical wound was thoroughly healed, I resorted to nephrotomy. The large triangular calculus was tightly embedded in the parenchyma, so that it had to be mostly shelled out with the knife. (Fig. 1, *b* and *d*.) The patient was discharged from the hospital four weeks afterwards. Fig. 1, *c* and *e*, shows the calculi after removal. It is interesting to note the small calculus which was found near the lower surface of the large renal concretion. If not removed, it would most probably have formed the nucleus for a third calculous formation in the bladder; Fig. 1 (*d* and *e*) shows the calculi skiagraphed after removal in order to demonstrate their density. The vesical as well as the renal calculus consists of oxalate of lime and the outer layer shows a smaller degree of density than the inner.

Another case of great skiagraphic interest was operated on at the Post-graduate Hospital on the same day. It was that of a lady of thirty-six years, who thirteen years ago began to suffer from violent pain in the right lumbar region. Examination of the urine revealed the presence of pus. Nephrotomy disclosed a calculus of moderate size surrounded by pus. It was supposed then that the calculus was the source of the suppuration, and consequently a speedy recovery was expected. This expectation did not become realized, a fistula remaining. The patient improved considerably, but the fistula did not close; so that after the lapse of a year nephrectomy was advised. To this the patient would not submit, as her general condition had meantime become very good, and the discharge had decreased.

About a year later the fistulous tract closed; more pus appeared in the urine and the left side became painful. Left-sided nephrotomy was now done, and a large abscess evacuated. The patient improved again and the opening closed, but the pyuria continued, the patient's condition varying considerably.

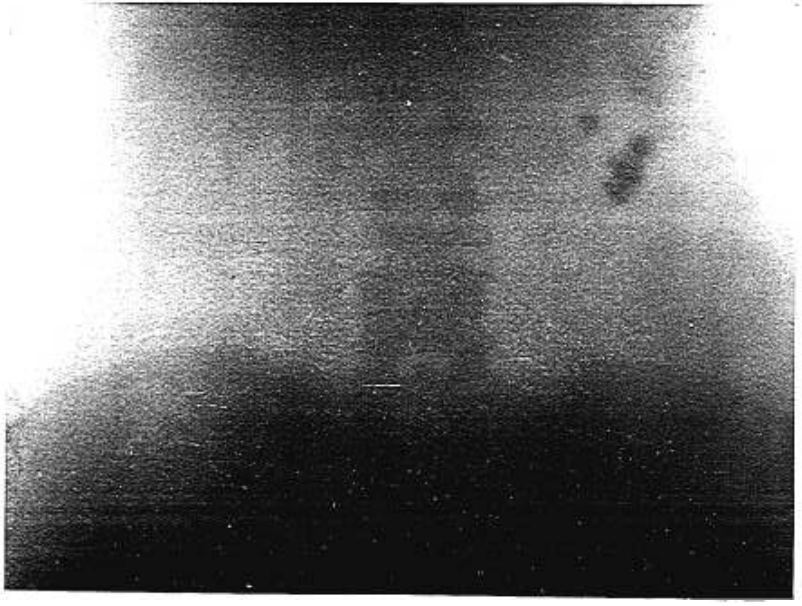
When I saw her for the first time, I suggested skiagraphic examination in addition to the other modern diagnostic means, cryoscopy, ureteroscopy; but the patient said, "There is no necessity for examining for nephrolithiasis, because 'the' stone was removed by the surgeon." I mention this as an interesting

instance of misleading argument. I, of course, insisted upon my proposition. The result is shown in Fig. 3, which reveals the faint outlines of calculi in the right lumbar region. Fig. 4, obtained by the aid of the diaphragm, shows the calculi well marked. It was taken in the slightly oblique direction, the diaphragm being pressed inwardly underneath the rib-arch. The criteria of a good skiagraph—viz., the last rib, the vertebræ, and the ileopsoas muscle—are well marked. The ilium is also, of course, conspicuous. Fig. 4, *b*, shows the calculi, which consisted of oxalate of lime, after their removal, while Fig. 4, *c*, indicates their degree of translucency. In all of them two layers of different density are noticeable.

The calculi had to be shelled out, not without difficulty, the irregular surface forming an impediment. The perirenal structures were matted and hardened, a natural consequence of the long-standing suppuration and inflammation. The adhesion was so dense that the kidney could not be lifted out, and great care had to be exercised during the whole procedure. (This is another point against the formation of normal blood circulation after decapsulation.) The third stone from above had a sharp triangular edge. Recovery took place in two weeks, the patient then being able to go round. Three weeks after the operation, febrile elevations began, and the left side became painful. An abscess formed, which was promptly discharged. Exploration of the abscess-cavity revealed the presence of a long sinus leading to the opposite side just in front of the spinal column. The patient improved slowly, and is up at the present writing, the thorough closing of the wound being expected in a short time.

The epicrisis of this case suggests that nephrolithiasis existed at the time of the first operation, when the Röntgen method was unfortunately not yet available. The very able surgeon who operated at that time undoubtedly examined the kidney carefully, but was unable to palpate the calculi through the parenchyma. The advice given later, when the fistula did not close, suggests that he thought the kidney to be in a state of destruction, rather than assumed the presence of any more than "the" stone, which would under the circumstances have been most natural. Under the most careful wound treatment and the good care of the intelligent patient, the fistula closed, but the pus was retained in the depth, and probably found a way to the opposite side, necessitating

FIG. 3.



GENERAL SKIAGRAPH OF RENAL REGION, SHOWING FOUR CALCULI ON THE LEFT SIDE.

FIG. 4.

RENAL CALCULI (SEE FIG. 3), TAKEN WITH THE AID OF THE AUTHOR'S DIAPHRAGM.

RENAL CALCULI AFTER REMOVAL.

RENAL CALCULI SKIAGRAPHED AFTER REMOVAL.

the incision on the left side. It is evident, that if the Röntgen method had been available at the time of the first operation, the remaining calculus, which penetrated the whole kidney, so to say, would have been recognized and removed at once, thus sparing years of suffering.

Skiagraph No. 4 not only shows the number of the renal calculi, their size and their shape, but also localizes them. After the surgeon has removed the four calculi, which can be identified with those of the plate, no further searching is required, while in case there is only a faint reproduction the kidney must be nearly bisected in order to ascertain whether there were any additional calculi left.